

POWERED ANTITHROMBOTIC FOOT MOBILITY DEVICE

The application claims priority from U.S. Provisional Ser. No. 60/313,541, filed Aug. 20, 2001, which is hereby incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates broadly to exercise devices. More particularly, this invention relates to exercise devices which promote circulation in the lower extremities by movement of the foot about a pivot.

2. State of the Art

Deep vein thrombosis (DVT) refers to the formation of a thrombus (blood clot) within a deep vein, commonly in the thigh or calf. The blood clot can travel to the lungs, resulting in pulmonary embolism, a potentially life-threatening condition.

DVT occurs when the flow of blood is restricted in a vein, and can be caused by poor circulation because of problems such as heart disease, a recent heart attack or stroke, varicose veins, or from inactivity or prolonged bed rest. Recently, a lot of attention has been focused on DVT developed during long airplane

1 flights and deaths resulting therefrom. In fact, DVT has been  
2 dubbed 'economy class syndrome' because the less expensive seats  
3 in a plane have less leg room, limited leg movement. However, DVT  
4 is not confined to economy class or to long haul flights.

5  
6 In view of current and impending lawsuits by passengers with  
7 respect to DVT, airlines have become proactive in trying to  
8 prevent the condition and are now directing passengers to get up  
9 and walk around the airplane cabin at least once an hour to  
10 increase blood circulation. However, flights are subject to meal  
11 service and turbulence which limit the amount of time available  
12 for passengers to exercise their legs. Moreover, flights are  
13 crowded and it is not feasible for all the passengers to walk  
14 through the narrow aisles in the cabin.

15  
16 As a response, a number of devices are being promoted to  
17 increase blood circulation while a passenger remains seated. For  
18 example, the LYMPHA-PRESS® SKY WALKER™ device by Mego Afek of  
19 Kibbutz Afek, Israel, is a portable, foldable exercise device  
20 operated from a seated position. The device includes two foot  
21 pedals which are not subject to any resistance other than minimal  
22 friction forces. When the user wants to increase circulation, the  
23 pedals can be easily moved by the feet of a user in a pedaling  
24 motion. The simple pedal movement of the user's feet effects  
25 contraction of the calf muscles which assists in moving venous

1 blood back to the heart, augmenting arterial blood inflow and  
2 preventing thrombosis.

3  
4 However, this and similar devices have a common drawback when  
5 used for the purpose of preventing DVT on long airplane flights;  
6 they require too much effort. Even the SKY WALKER™ device, which  
7 offers substantially no resistance, requires the user to  
8 concentrate on the movement of the feet. That is, if the user  
9 concentrates on the in-flight movie or a magazine, it is easy to  
10 forget to continue to pedal and DVT can result.

11  
12 U.S. Patent No. 6,217,488 to Bernardson discloses another  
13 lower leg exerciser which includes a base, foot pedals which rock  
14 along a pivot relative to the base, and a motor adapted to rock  
15 the pedals back and forth. When feet are placed on the pedals,  
16 the feet are rocked automatically and blood circulation in the  
17 legs is increased. However, the Bernardson device has several  
18 drawbacks. First, the rocking movement of the feet causes the  
19 knees to move up and down. This motion is not suited to airplane  
20 travel, as the room in front of a seat is limited, and once the  
21 user's feet are raised and placed on the device, the rocking  
22 motion may cause the user's knees to contact the back of the chair  
23 in front, may cause interference with a tray table, or may be  
24 annoying if, e.g., trying read a book held on the lap. A second  
25 drawback is that the Bernardson device cannot be reconfigured to a

1 smaller size for increased portability. A third drawback is that  
2 should a power supply be unavailable for powering the device,  
3 i.e., no suitable power outlet or depleted batteries, the device  
4 does not provide anti-DVT exercising of the legs.

5  
6 SUMMARY OF THE INVENTION  
7

8 It is therefore an object of the invention to provide a foot  
9 mobility device which moves the feet in a manner which limits knee  
10 movement.

11  
12 It is another object of the invention to provide a foot  
13 mobility device which requires no effort on the part of the user.

14  
15 It is an additional object of the invention to provide a foot  
16 mobility device which is portable.

17  
18 It is also an object of the invention to provide a foot  
19 mobility device which has a low profile.

20  
21 It is still another object of the invention to provide a foot  
22 mobility device which has a collapsed configuration.

1        It is a further object of the invention to provide a foot  
2 mobility device which can be used as either a passive (powered) or  
3 active (non-powered) exercise device.

4  
5        In accord with these objects, which will be discussed in  
6 detail below, a foot mobility device is provided and includes a  
7 body, two pedals rotatable about a common axis preferably in  
8 opposition to each other and relative to the body, and a motor  
9 drive assembly coupled to the pedals. The feet of a user are  
10 placed on the pedals, and the motor drive assembly is powered to  
11 cause movement of the pedals even while the user is completely  
12 passive; i.e., without any active participation by the user.  
13 Moreover, the sensation received by the use, rather than being one  
14 of typical "exercise", is massage-like and therapeutic, all while  
15 providing the same benefit of increased blood circulation due to  
16 contraction and relaxation of the calf muscle. Moreover, the foot  
17 mobility device may be moved between an open configuration adapted  
18 for use of the device and a collapsed configuration having a low  
19 profile and adapted for storage and portability.

20  
21        According to one embodiment of the invention, the foot  
22 mobility device includes a generally vertically oriented body, two  
23 foot pedals hingedly coupled on either side of the body to rotate  
24 substantially ninety degrees relative to the body between a closed  
25 position in which each foot pedal is substantially parallel to the

1 body and an open position in which each foot pedal is  
2 substantially perpendicular to the body. In the open position,  
3 the pedals are adapted to cause feet placed thereon to rotate  
4 about the ankle joint.

5  
6 According to other embodiments of the invention, the foot  
7 mobility device includes a preferably flat base, two pedals  
8 rotatable about a heel pivot, and a motor mechanism which rotates  
9 the pedals. The motor mechanism is movable from a first position  
10 in which it lies against the base to an upright second position in  
11 which it is adapted to move the pedals. The pedals can be  
12 configured to lie flat against the base for storage and  
13 portability. In addition, the pedals can preferably be disengaged  
14 from the motor drive so that the device can be used as an active  
15 exercise device and also to facilitate moving the pedals for  
16 folding the device in a highly portable configuration.

17  
18 It will be appreciated that with the foot mobility device of  
19 the invention, a highly compact and therefore portable powered  
20 foot mobility device is provided.

21  
22 Additional objects and advantages of the invention will  
23 become apparent to those skilled in the art upon reference to the  
24 detailed description taken in conjunction with the provided  
25 figures.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a first embodiment of a portable foot mobility device with the pedals in an open configuration;

Fig. 2 is a perspective view similar to Fig. 1, but in which a left housing element has been removed such that the interior of the housing can be seen;

Fig. 3 is a perspective view similar to Fig. 2, with the additional removal of the left pedal, left rocker, and left gearbox housing, and with front and rear legs in a closed position;

Fig. 4 is a perspective view of the first embodiment of the portable foot mobility device with the legs in an open position;

Fig. 5 is a perspective view of the foot mobility device in a closed configuration;

Figs. 6(a) - 6(f) are perspective views similar to Fig. 4 illustrating the range of motion of the right pedal;

1        Fig. 7 is a perspective view of a second embodiment of the  
2 foot mobility device of the invention in an open configuration;

3  
4        Fig. 8 is a side elevation view the second embodiment of the  
5 foot mobility device of the invention in an open configuration;

6  
7        Fig. 9 is a top view of the second embodiment of the foot  
8 mobility device of the invention in a closed configuration;

9  
10       Fig. 10 is a side elevation view of the second embodiment of  
11 the foot mobility device of the invention in an open  
12 configuration;

13  
14       Figs. 11 - 13 are schematic views of the gear and switch  
15 assembly which operates reciprocable movement of the foot pedals  
16 in the second embodiment of the foot mobility device of the  
17 invention;

18  
19       Figs. 14 and 15 are schematic views of the engagement and  
20 disengagement, respectively, of the gearbox from the drive gear,  
21 and also of the power switch operation in the second embodiment of  
22 the foot mobility device of the invention;

23  
24       Figs. 16(a) - 16(d) are schematic views of a third embodiment  
25 of a foot mobility device according to the invention, shown in



1 several positions as being moved from an open configuration to a  
2 closed configuration;

3  
4 Figs. 17 and 18 are schematic view of a first mechanism for  
5 automatically disengaging the drive train from the pedals in the  
6 second and third embodiments of the invention;

7  
8 Fig. 19 is a schematic view of a second mechanism for  
9 automatically disengaging the drive train from the pedals in the  
10 second and third embodiments of the invention;

11  
12 Fig. 20 is a perspective view of a fourth embodiment of the  
13 invention, in a collapsed configuration;

14  
15 Fig. 21 is a perspective view of the fourth embodiment of the  
16 invention, in an open configuration;

17  
18 Fig. 22 is a perspective view of the fourth embodiment of the  
19 invention, illustrating the maximum rise of one pedal relative to  
20 the other;

21  
22 Fig. 23 is a perspective view of the fourth embodiment of the  
23 invention with the left pedal removed to show the four-bar linkage  
24 support of the motor housing in the open configuration;

1        Fig. 24 is a perspective view of the fourth embodiment of the  
2 invention, in an open configuration also showing the pedal at full  
3 travel (maximum rise);

4  
5        Fig. 25 is a perspective view of one side of the gear box of  
6 fourth embodiment;

7  
8        Fig. 26 is a perspective view of the other side of the gear  
9 box of fourth embodiment;

10  
11       Fig. 27 is a perspective view of the gear train, with the  
12 device in the 'OFF' position such that the idler gear of the gear  
13 train is not engaged;

14  
15       Fig. 28 is a perspective view of the gear train, with the  
16 device in the 'ON' position such that the idler gear of the gear  
17 train motor is engaged;

18  
19       Fig. 29 is a perspective view of the gear train, four bar  
20 linkage, and switching mechanism; and

21  
22       Fig. 30 is a schematic view of a passenger compartment of a  
23 vehicle having foot mobility device according to the invention  
24 integrated into or coupled to the floor thereof.

## 1 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

2  
3 Turning now to Fig. 1, a first embodiment of a foot mobility  
4 device 10 is shown. The device generally includes an upstanding  
5 housing 12 (preferably defined by left and right housing members  
6 14, 16), and left and right pedals 18, 20 rotatable relative to  
7 the housing. The left and right pedals 18, 20 function as foot  
8 rests when in the open position shown in Fig. 1 (oriented  
9 perpendicular to the housing), but are respectively rotatable by  
10 ninety degrees about hinges 22 into an upright position  
11 substantially parallel to the housing (Fig. 6), as discussed  
12 below. Front and rear legs 24, 26 respectively, described in more  
13 detail below, support the device on a surface away from the floor  
14 to allow clearance for pedal movement and provide stability for  
15 the housing 12.  
16

17 Turning now to Figs. 2 and 3, the pedals 18, 20 are coupled  
18 to a gearbox 30 having a housing 31 defined by left and right  
19 housing elements 32, 33. More particularly, the pedal hinges 22  
20 couple the pedals 18, 20 to left and right rockers 34, 36 which  
21 are, in turn, coupled to the gearbox 30 with left and right rocker  
22 links 38, 40 using left and right rocker bushings 42, 44. Three  
23 preferably identical roller bearings 46 are mounted to the housing  
24 on roller bearing mounts 48. The weight of the user's feet and  
25 legs tends to force the rockers 34, 36 toward each other, and the

1 roller bearings 44 maintain separation between the two rockers 34,  
2 36. The diameter of each of the roller bearings 46 is equal to  
3 the desired distance between the left and right rockers.

4  
5 Referring particularly to Fig. 3, the gearbox housing 31  
6 encases a motor 50, powered by batteries 52 located inside the  
7 housing 12. The motor 50 has an output shaft (not shown) which  
8 rotates in a preferably counter-clockwise direction, as viewed  
9 from the shaft end of the motor. The output shaft is provided  
10 with a motor pulley 54 which drives a worm pulley 56 by means of a  
11 belt 58 for purposes of isolating motor vibration and reducing  
12 noise. The worm pulley 56 is preferably a one-piece component  
13 with a pulley 60 at one end and a right-handed worm screw 62  
14 coaxially located at the other end. The worm pulley 56 is  
15 rotatably mounted on a steel shaft (not shown) that is rigidly  
16 provided in gearbox housing 31. The worm screw 62 engages a  
17 shaft-mounted compound worm gear 64. The compound worm gear 64  
18 has a spur gear 66 coaxially affixed to the worm gear, and the  
19 spur gear 66 engages a compound gear 68. The compound gear 68  
20 engages an idle gear 70 which, in turn, engages a cam gear 72.  
21 Unlike the rest of the gears, the cam gear 72 preferably does not  
22 pivot on a shaft, but rather includes an annular projection 74 on  
23 each of its sides which is inserted into corresponding holes 76 in  
24 the left cam gear bearing 78 and right cam gear bearing (not  
25 shown).

1       The cam gear 72 also has an additional annular projection 80  
2 on each of its sides. The projections 80 are smaller in diameter  
3 than projection 74 and are parallel to, but not coaxial with, the  
4 axis of rotation of cam gear 72. These projections, one on the  
5 left side and one on the right, are 180° out of phase with each  
6 other. The projections 80 provide a pivot joint for the  
7 attachment of the left and right rocker links 38, 40. The  
8 rotation of cam gear 72 causes the gearbox ends of the rocker  
9 links to travel in circular paths. The other end of each of the  
10 rocker links is attached to a respective rocker 34, 36. For  
11 example, right rocker link 40 is rotatably mounted to the right  
12 rocker 36 by means of rocker link bearing 44. The rocker link  
13 bearing 44 is screwed to the right rocker 36 and has a flange 82  
14 such that the right rocker link 40 is trapped between the flange  
15 82 and the face 84 of the rocker 36.

16  
17       The right rocker 36 is pivotably mounted on a rocker bearing  
18 86 which is located and trapped between bosses 88 that project  
19 inward from both the left and right housing members 14, 16.

20  
21       Referring to Figs. 3 and 4, the front leg 24 is connected to  
22 the gearbox 30 with a gearbox link 89. When the front leg 24 is  
23 in the closed (folded) position (Fig. 3), the gearbox 30 is spaced  
24 apart from the front wall 90 of the housing 12. When the front  
25 leg 24 is pulled into the open position (Fig. 4), the gearbox link

1 90 is pulled, which in turn moves the gearbox 30 away from the  
2 rockers 34, 36 and toward the front wall 90 of the housing 12  
3 (compare Figs. 3 and 4). The movement of the gearbox 30 away from  
4 the rockers 34, 36 pulls the rocker links 38, 40, which pulls the  
5 rockers 34, 36. In the folded position of Fig. 3, the position of  
6 the gearbox 30 locates the rocker links 38, 40 and rockers 34, 36  
7 at the midpoint of the pedal movement cycle, where each pedal 18,  
8 20 is halfway between up and down and parallel to each other such  
9 that the pedals, when folded about hinges 22, are aligned with the  
10 housing 12, as shown in Fig. 5. When the front leg 24 is unfolded  
11 such that the gearbox 30 is moved toward the front wall 90 of the  
12 housing as shown in Fig. 4, the position of the gearbox 30, rocker  
13 links, and rockers orients the pedals at an angle relative to a  
14 surface on which the foot mobility device rests (i.e., in the  
15 middle position of the pedal movement cycle), and ready for use.  
16 It is noted that the cam gear 72 is not at all moved by the  
17 folding the front leg 24 between the open and closed positions.

18  
19 Still referring to Figs. 3 and 4, the rear leg 26 telescopes  
20 into and out of a rear portion 92 of the housing 12. A resilient  
21 catch 94 automatically locks against the bottom 96 of the housing  
22 when the rear leg 26 is moved into an extended position, but may  
23 easily be released by finger pressure to collapse the rear leg  
24 back into the housing.

1 Referring now to Figs. 6(a)-(f) the full range of motion for  
2 the right pedal 20 is shown, with an understanding that left pedal  
3 18 (Fig. 1) undergoes a similar though opposite motion. Fig. 6(a)  
4 depicts the lowest position for pedal 20, Fig. 6(c) depicts the  
5 middle, or folding, position for the pedal, Fig. 6(b) depicts a  
6 position between Figs. 6(a) and 6(c), Fig. 6(e) depicts the  
7 maximum height position for pedal 20, Fig. 6(d) depicts a position  
8 between Figs. 6(c) and 6(e), and Fig. 6(f) depicts the pedal 20 on  
9 its way back toward the lowest position. The axis of rotation of  
10 the pedals 18, 20 is substantially about the location of the  
11 ankles of the feet placed on the pedals. This is facilitated by  
12 placing the foot pedals below the axis of rotation.

13  
14 Referring back to Fig. 5, it is appreciated that the folding  
15 of the pedals 18, 20 against the housing 12 provides a device 10  
16 with a small profile which is highly suitable for storage and  
17 travel. In the folded position, the entirety of the device has a  
18 preferred length to thickness to height ratio of approximately 14  
19 to approximately 3 to approximately 7. These relative dimensions  
20 provide a device suitable for carry-on luggage or even a  
21 briefcase.

22  
23 Turning now to Figs. 7 and 8, a second embodiment of a  
24 portable foot mobility device 100 is shown. The foot mobility  
25 device 100 generally includes a base 112, left and right foot

1 pedals 118, 120 rotatable up and down relative to the base on a  
2 hinges 122 at heel portions of the pedals, and a motor housing 130  
3 also movable relative to the base. The base 112 includes a  
4 battery compartment 132 which is electrically coupled to a motor  
5 140, discussed below, in the motor housing 130. The motor housing  
6 130 is coupled to a pair of movable trusses 134, 136 and the motor  
7 housing and trusses are movable between a closed configuration, in  
8 which both are substantially flush with the base (Figs. 9 and 10),  
9 and an open configuration in which the trusses and a lower portion  
10 of the motor housing 130 assume a stable triangular configuration  
11 (Figs. 7 and 8).

12  
13 Turning now to Fig. 11, the motor housing 130 includes a  
14 drive assembly. The drive assembly includes a motor 140 and a  
15 gearbox 180 (Fig. 14) provided with gears. The motor 140 has an  
16 output shaft 142 provided with a spur gear 144. The spur gear 144  
17 engages a first shaft-mounted compound gear 146 which engages a  
18 second shaft-mounted compound gear 148 to step down the rotational  
19 transmission of the motor 140. A spur gear portion 150 of the  
20 second compound gear 148 engages a spur gear portion 152 of a  
21 drive gear 154, which is located outside the gear box 180. The  
22 drive gear 154 also includes a pulley portion 156. Left and right  
23 pulleys 158, 160 are horizontally offset on either side of the  
24 pulley portion 156, and the pulley portion of the drive gear 154  
25 moves a rope 162, or other flexible transmission line such as a



1 cable, across the pulleys 158, 160. The left and right pedals  
2 118, 120 are each coupled to one end of the rope 162, as shown  
3 with respect to the left pedal in Fig. 8.

4  
5 The motor drive 130 is also provided with a switch 170 having  
6 a contact arm 172 movable between two positions, with each  
7 position causing the motor 140 to rotate in an opposite rotational  
8 direction. The drive gear 154 includes a peg portion 174 on its  
9 face which extends sufficiently therefrom to interfere with the  
10 contact arm 172 at predetermined rotational positions so that the  
11 switch 170 may be activated.

12  
13 The motor drive 130 operates the pedals 118, 120 in an up and  
14 down motion as follows. The contact arm 172 of the switch 170 is  
15 oriented in a position (e.g., to the left) causing  
16 counterclockwise rotation of the motor 140. Rotation of the spur  
17 gear 144 at the end of the motor shaft 142 results in rotation of  
18 gears 146, 148, 150 and consequently clockwise rotation of the  
19 drive gear 152, as indicated by the arrow in Fig. 11. The peg  
20 portion 174 on the drive gear 152 is thereby rotated to cause the  
21 peg portion 174 to contact the contact arm 172 (Fig. 12), and then  
22 to cause the contact arm to move into the second position which  
23 causes clockwise rotation of the motor and counterclockwise  
24 rotation of the drive gear 152 (Fig. 13). The drive gear 152 and  
25 peg 174 are then rotated counterclockwise until the peg 174 again

1 contact and moves the contact arm 172 to reverse the direction of  
2 the motor 140. Each time the drive gear 152 is rotated in an  
3 opposite direction, the rope is likewise pulled in an opposite  
4 direction, with the pedal at one end of the rope being raised, and  
5 the pedal at the other end of the rope being lowered.

6  
7 Turning now to Fig. 14, according to a preferred aspect of  
8 the invention, the gears in the gearbox 180 may be disengaged from  
9 the drive gear 152 to facilitate closing (collapsing) the foot  
10 mobility device such that both pedals are substantially flush with  
11 the base 112. That is, when the gearbox is disengaged, the rope  
12 attached to the pedals may be moved without having to rotate all  
13 the gears in the gearbox against the resistance of the motor.  
14 According to a currently preferred disengagement (and engagement)  
15 mechanism, the gearbox 180 is provided with a cam 182 on its  
16 surface. The gearbox 180 is vertically movable within a slot  
17 defined by walls 184, 186. A horizontally movable lever 188 is  
18 provided with a cam slot 190 in which the cam 182 rides. The  
19 lever 188 preferably includes left and right button portions 192,  
20 194. When the lever 188 is positioned to the left, as shown in  
21 Fig. 14, the cam 182 is forced into a portion of the slot 190  
22 which causes the gearbox 180 to be in a vertical position which  
23 results in engagement of a gear in the gearbox with the drive gear  
24 152. When the lever is moved to the right, as shown in Fig. 15,  
25 the cam 182 is forced vertically downward in the cam slot 190, and

1 the gear box 180 is disengaged from the drive gear 152. With the  
2 gearbox disengaged, the foot mobility device may be used as an  
3 active exercise device in which the user moves the pedals. This  
4 is particularly useful when the batteries are depleted, or when  
5 completely silent operation is desired.

6  
7 Moreover, the same mechanism can be, though not necessarily  
8 is, used to complete and disrupt a power switch to activate and  
9 deactivate (i.e., turn ON and OFF) the device 100. Referring back  
10 to Fig. 14, contacts 196, 198 are required to be in electrical  
11 contact for the motor to receive power from the battery source.  
12 Contact 198 is resiliently biased away from contact 196. When the  
13 gearbox 180 is in the engaged position, gearbox forces contact 198  
14 against contact 196, providing power from the battery source to  
15 the motor. However, when the gearbox is disengaged (Fig. 15),  
16 contact 198 moves away from contact 196 and power is removed.

17  
18 According to another preferred aspect of the invention, the  
19 lever is preferably actuatable by foot, with the left and right  
20 button portions 192, 194 extending outside the housing 12, as  
21 shown in Figs. 7 through 9. As such, once the device is in the  
22 open position, it may be easily turned ON by using a user's foot  
23 to move the lever 188 into the ON position and likewise turned OFF  
24 in the same manner; i.e., by moving the lever in the opposite  
25 direction with one's foot. The foot activation is very

1 advantageous, especially when seated in a cramped airplane seat,  
2 where there is little room to bend to the floor and operate a  
3 device.

4  
5 Turning now to Figs. 16(a) - 16(d), a third embodiment of the  
6 foot mobility device 200, substantially similar to the second  
7 embodiment, is shown. The foot mobility device 200 includes two  
8 pedals (only left pedal 218 shown in the figures) hinged to a base  
9 212, a motor drive (not shown) in a central foldable motor drive  
10 housing 230, and a rope (or cable) 262 connecting the unhinged end  
11 of the pedals to the motor drive mechanism. When in the opened  
12 position of Fig. 16(a) and powered, the motor drive causes the  
13 pedals to move up and down about their hinges 222. When one pedal  
14 is down the other is up. The motor drive housing 230 is coupled  
15 to the base 212 by a four bar linkage (with the two left bars 234,  
16 235 being shown, and similar right bars not shown) allowing the  
17 housing 230 to fold into intermediary positions shown in Figs.  
18 16(b) and 16(c), and finally into the flat position of Fig. 16(d).  
19 Simultaneously with the folding, the tension on the rope 262 is  
20 released, such that the foot pedals 218, 220 are allowed to fold  
21 flat as well. To further allow for easy folding, the device 200  
22 when folded automatically switches to OFF mode and disengages the  
23 motor from the gear train allowing the rope 262 to move freely so  
24 that if one pedal is all the way up the rope can easily adjust as  
25 the device is folded.

1 Referring to Fig. 17, one mechanism for automatically  
2 disengaging the drive train from the pedals is shown. A cog 260  
3 is slidably coupled to the gearbox 280, and is biased by a first  
4 spring 262 toward the lever 288. A cable 261 is coupled at one of  
5 its ends to the cog 260, and at the other of its ends it is  
6 coupled to elsewhere on the device, as discussed below. The lever  
7 288 includes a catch 264, and the cog 260 includes a beveled end  
8 266 engageable within the catch 264 when the lever 288 is  
9 positioned such that the device 200 is in an ON position. A  
10 second spring 268 is coupled to the lever 288 and tensioned to  
11 pull the lever 288 with sufficient force move the cam 282 relative  
12 to the cam slot 290 such that the gearbox 280 is moved into a  
13 disengaged position. When the drive mechanism housing 230 is  
14 upright, the cable 261 is slack allowing the cog 260 to move under  
15 the tension of the first spring 262 so that the beveled end 266 of  
16 the cog 260 enters the catch 264 and holds the lever 288 in the  
17 engaged position, locking the lever in place against the tension  
18 of the second spring 268. Referring to Fig. 18, as soon as the  
19 housing (130 in the second embodiment, and 230 in the third  
20 embodiment) starts to move from the vertical position, either in  
21 its four bar linkage configuration (Figs. 16(a)-16(d)) or in its  
22 sliding configuration (Figs. 7 and 8), the cable 261 is caused to  
23 go taught, pulling the cog 260 from the catch 264, and allowing  
24 the lever 288 to spring, under the force of the second spring 268,  
25 into the OFF position, removing power and disengaging the motor

1 drive. For example, in the four bar linkage configuration of  
2 Figs. 16(a)-(d), either the pivoting action of the lower or upper  
3 bars 234, 235 can cause the cable 261 to go taught. In the  
4 sliding version of Figs. 7 and 8, either the pivoting of bars 134,  
5 136 or a rocker on the base 112 can be used to cause the link 261  
6 to go taught when the housing 230 starts to move out of its  
7 upright position.

8  
9 Referring back to Fig. 17, it is appreciated that even when  
10 the cog 260 is engaged in the catch 264 and the cable 261 is  
11 slack, the lever 288 may be manually moved to disengage the drive  
12 mechanism such that the device 200 may be used as an active  
13 exerciser. Manual application of force to the lever 288 overcomes  
14 the frictional engagement of the beveled end 266 of the cog 262 in  
15 the catch, and the second spring 268 holds the lever 288 in the  
16 disengaged position (Fig. 18).

17  
18 Referring to Fig. 19, a second mechanism for automatically  
19 disengaging the drive train from the pedals is shown. A  
20 preferably L-shaped lever bar 360 having first and second arms  
21 362, 364 is rotatably coupled to the lever 388. The cable 361 is  
22 coupled to the first arm 362. When the cable 361 is pulled (i.e.,  
23 when the housing 230 is folded), the lever bar 360 is rotated  
24 until the second arm 364 contacts the wall 184. Further  
25 rotational movement of the lever bar 360 causes the lever 388 to

1 move to the right, thereby moving the cam 382 relative to the cam  
2 slot 390, and thereby disengaging the motor drive from the pedals.

3  
4 Turning now to Figs. 20 through 22, a fourth embodiment of a  
5 foot mobility device 400 is shown. In Fig. 20 the device is shown  
6 in a collapsed or folded configuration, with the pedals 418, 420  
7 substantially flushly seated on a base 412 (Fig. 21), and a motor  
8 housing 430 also in a flush folded position. By pressing a latch  
9 release 450, the housing 430 is released from an engagement  
10 further discussed below, and the device may be moved into the open  
11 configuration of Fig. 21. Fig. 22 shows the maximum travel or  
12 rise of a pedal 420 relative to the base 412. The pedals rotate  
13 about axes through their heel portion 419, 421.

14  
15 Referring to Figs. 22 and 23, a compartment 452 is provided  
16 on the base 412 under the right pedal 420 to house the electronics  
17 which control the hereinafter described motor assembly 454 (Figs.  
18 25 and 26), and a battery compartment 456 is provided under the  
19 left pedal 418. Fig. 23 also better illustrates the above  
20 mentioned latch release 450 and spring-biased latches 458 which  
21 are adapted to hold and then release catches 460 on the end of the  
22 motor housing 430. Referring to Fig. 24, the pedals 418, 420 each  
23 also include a catch 462 which is caught under the motor housing  
24 430 when the motor housing is in the closed position to hold the  
25 pedals in a closed position.

1 Referring back to Fig. 23, the housing is coupled to the base  
2 with a four-bar linkage 464. When in the fully upright position  
3 of Fig. 23, the housing 430 rests on the base 412.

4  
5 Referring again to Fig. 24, the pedals 418, 420 have a rear  
6 depressed area 470, 472 which functions as a heel rest. In  
7 addition, the pedal is wider at the heel end. The user's feet can  
8 be placed laterally on the heel ends to position the feet in a  
9 relatively parallel orientation, or the feet can be placed  
10 medially on the heel ends to splay the feet. The foot position  
11 can be selected according to user comfort.

12  
13 Referring to Figs. 24 and 25, the pedals 418, 420 are  
14 preferably coupled to the motor assembly 454 with ropes 474, 476.  
15 The motor assembly 454 includes a gear train 480 coupled to a  
16 preferably vibrationally-isolated motor 482. The gear train 480  
17 includes a main pulley gear 484 and left and right idler pulleys  
18 486, 488. One rope 474 extends from the left pedal 418 clockwise  
19 about the left idler pulley 486 and then clockwise about the main  
20 pulley gear 484 to which it is then attached. The other rope 476  
21 extends from the right pedal 420 counterclockwise about a right  
22 idler pulley 488 and then counterclockwise about the main pulley  
23 gear 484 to which it is also then attached. Reciprocal rotation  
24 of the main pulley gear 484 by the gear train 480 causes the



1 pedals 418, 420 to move in an up and down motion about axes  
2 through the heel portions 419, 421 of the pedals.

3  
4 Referring to Fig. 26 and 27, a switch 490 is coupled to a  
5 linkage 492 which is coupled to an idler gear 494. The idler gear  
6 494 is coupled to the motor 482 and can be brought into and out of  
7 engagement with a portion of the gear train mechanically coupled  
8 to the main pulley gear 484. The linkage 492 is subject to the  
9 force of a spring 496 (Fig. 26) which stably holds the idler gear  
10 494 in its current position until sufficient manual force is  
11 provided to the switch 490 to move the linkage 492 and thereby  
12 alter the position of the idler gear 494. The switch 490 also  
13 operates to provide and remove power from the batteries (in the  
14 battery compartment 456) to the motor 482; i.e., to power 'ON' and  
15 'OFF' the device.

16  
17 In Fig. 27, the switch 490 and linkage 492 are positioned to  
18 provide the device in the 'OFF' mode and to locate the idler gear  
19 494 out of engagement with a gear 498 directly engaging the main  
20 pulley gear 484. In this configuration, the device may be used in  
21 an active mode; i.e., with the user providing the power to rotate  
22 the pedals. In Fig. 28, the switch 490 and linkage 492 are  
23 positioned to provide the device in the 'ON' mode, and locate the  
24 idler gear 494 in engagement with gear 498; i.e., such that the  
25 motor assembly moves the pedals in a reciprocating motion. In

1 addition, a clutch 500 is provided to prevent damaging force from  
2 being applied to a portion of the gear train and the motor, e.g.,  
3 if a user were to apply foot pressure counter to the movement of  
4 the pedals by the motor assembly 454.

5  
6 Turning to Fig. 29, a small L-shaped lever 502 is provided  
7 adjacent one of the supports 504 of the four bar linkage 464. If  
8 the device 400 is folded while the motor is engaged, upon folding,  
9 the L-shaped lever 502 contacts a rocker 506 which operates to  
10 move the switch 490 to an OFF position, thereby disengaging the  
11 pedals from the motor.

12  
13 Referring to Fig. 30, a passenger compartment 510 of a  
14 vehicle, e.g., a car, a truck, a plane, or a train, is shown. A  
15 foot mobility device 400 according to the invention is coupled to  
16 or integrated into the floor 512 of the compartment 510. As the  
17 embodiments of the devices can each be folded to assume a  
18 relatively low profile, when not in use the devices do not  
19 substantially encroach upon the leg room in the compartment.

20  
21 From the above, it is appreciated that several embodiments of  
22 the device can be used in either a passive (powered) mode or in an  
23 active (non-powered) mode. In the active mode the user simply  
24 pushes one foot down causing the device to raise the other foot,  
25 and thereby exercise the lower extremities.

1        In the above described foot mobility devices, the pedals  
2        operate to reciprocably move the feet about either the heel or  
3        ankle, but do not cause the exaggerated leg movement which results  
4        from rocking the feet, moving the feet about the ball of the foot,  
5        or pedaling the feet in a bicycle pedal motion. As such, the foot  
6        mobility device is particularly suitable for use in areas which  
7        provide little leg room and/or where it is desired to maintain the  
8        knees relatively still during use of the foot mobility device.

9  
10       There have been described and illustrated herein embodiments  
11       of a powered foot mobility device. While particular embodiments  
12       of the invention have been described, it is not intended that the  
13       invention be limited thereto, as it is intended that the invention  
14       be as broad in scope as the art will allow and that the  
15       specification be read likewise. Thus, while particular gear  
16       assemblies have been disclosed, it will be appreciated that other  
17       gear assemblies using fewer or more gears, and/or different types  
18       of gears can be used as well. In addition, while preferred  
19       housing designs have been illustrated, it will be understood that  
20       other housing designs can be used. Also, while the device is  
21       preferably battery powered, for portability, it is recognized that  
22       the device may be powered by an AC power source instead of a DC  
23       battery source, or by an AC power source which either bypasses the  
24       battery power source or can be used to recharge a rechargeable  
25       battery source. Furthermore, while in the second embodiment a

1 rope or other resilient element is used to move the pedals, it  
2 will be appreciated that other systems may be used to support and  
3 move the pedals. For example, gear-rotatable supports may be  
4 provided under the pedals. Also, while exemplar mechanisms for  
5 automatically disengaging the drive train for the pedals are  
6 described, it will be appreciated that other suitable mechanisms  
7 can be used. It will therefore be appreciated by those skilled in  
8 the art that yet other modifications could be made to the provided  
9 invention without deviating from its spirit and scope.